



AAAV RELIABILITY GROWTH PROJECTIONS



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ADVANCED AMPHIBIOUS ASSAULT VEHICLE PROGRAM**



AAAV MISSION



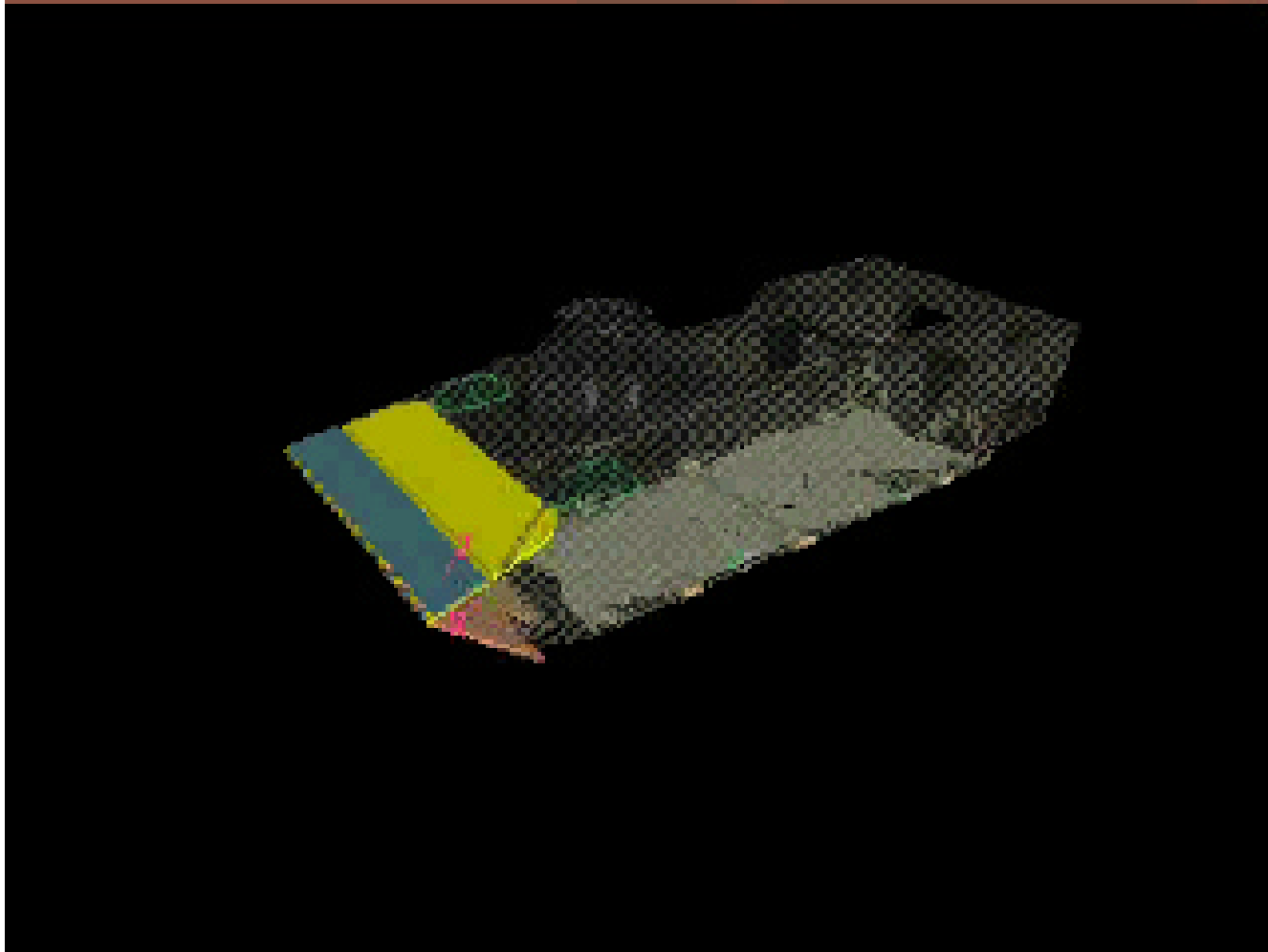
**Provide High Speed
Transport of Embarked
Marine Infantry From Ships
Located Beyond the Horizon
to Inland Objectives**



**Provide Armor Protected
Land Mobility and Direct
Fire Support During
Combat Operations**



Reconfiguration





KEY PERFORMANCE PARAMETERS



CRITERIA

THRESHOLD

OBJECTIVE

High Water Speed - Sea State 3, 3' significant wave height, for not less than one continuous hour

20 knots

25 knots

Land Speed - Forward speed on hard surface road

69 kph

72 kph

Firepower - Maximum effective range. Main armament range. Interoperability/ standard ammunition with other service(s)

1500m

2000m

Armor Protection - Any azimuth

14mm/300m

30mm/1000m

Reliability - Mean Time Between Operational Mission Failures

70 hrs

95 hrs

Carrying Capacity

17 Marines

18 Marines

Interoperability

* Information Exchange Requirements

**100% of
Critical *IERs**

**100% of Top
Level *IERs**

[illegible]



AAAV Testing Strategy



Concept Exploration



Hydrodynamic Test Rig



Automotive Test Rig

Technology Demonstrators

Program Development and Risk Reduction



- USER Juries
- Combined Arms Exercise
- Force on Force Modeling
- AAAV(C) EOA
- AAAV(P) EOA



Integrated Functionality

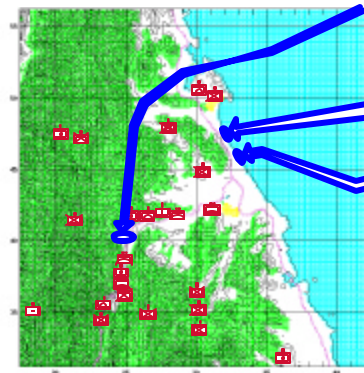
System Development and Demonstration

- 9 Vehicles - 8 (P) 1 (C)
- SDD OA
- Hot Weather
- Cold Weather OA
- RAM-D Testing
- IETM Validation/ Verification
- User Juries

*Multi-Vehicle Operations
Operational Suitability*

Production Readiness and Low Rate Initial Production

- IOT&E



*FUSL
IOT&E
Test to Prove*



Testing Highlights



- **Land Testing - 4,228 Miles**
- **Water Testing - 1924 Hours**
- **Firepower Testing**
- **Ballistic Hull & Turret Survivability Testing**
- **C4I Testing**
- **AAAV (P) and AAAV(C) EOA**
- **Logistics Demonstration (Training & Maintenance)**
- **IETM Demonstration**
- **User Juries**





Mission Critical Functions: Move, Shoot, Communicate, Carry & Protect



Move on Land



Carry



Move on Water



Communicate



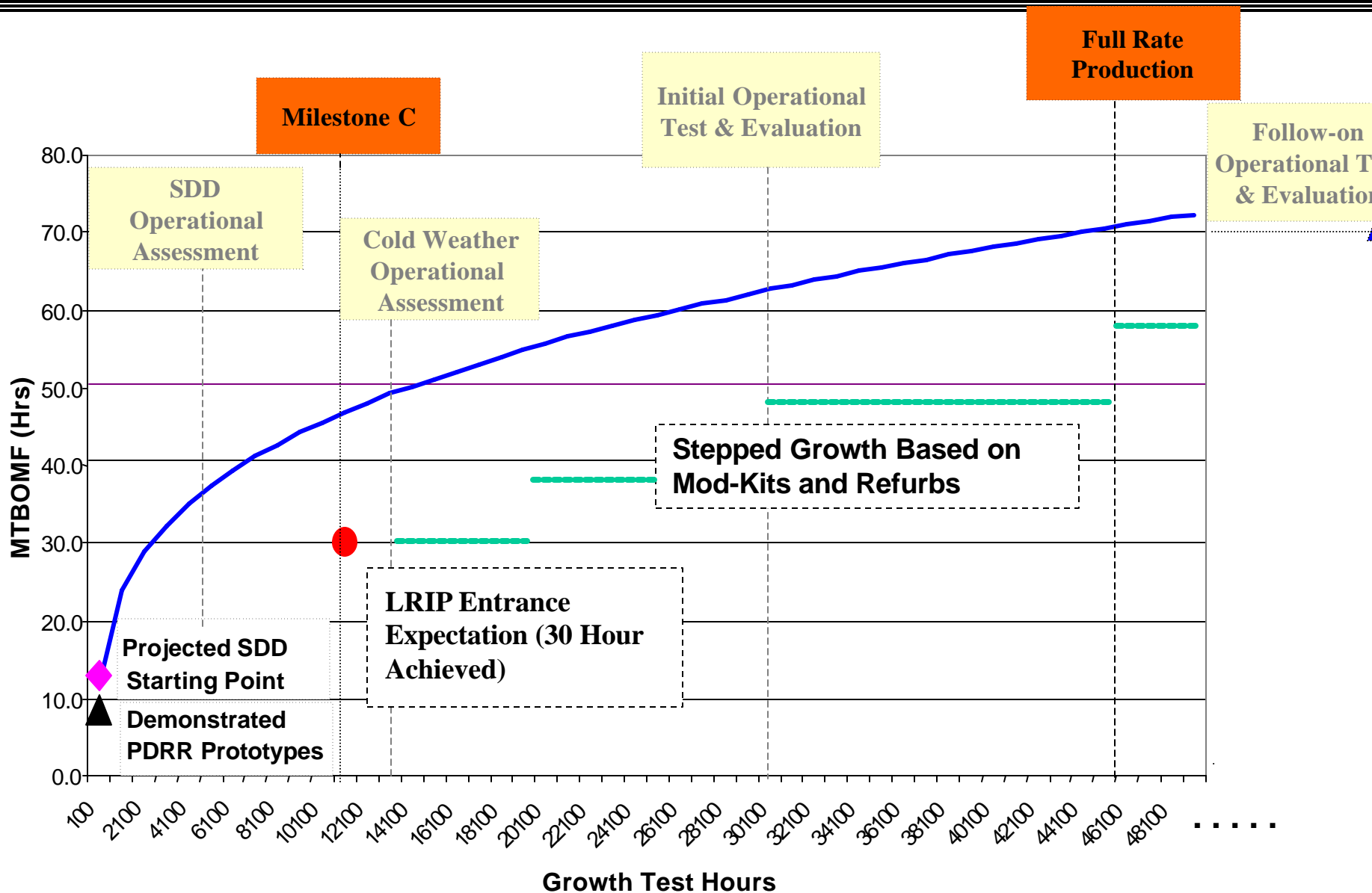
Shoot



Protect



IDEALIZED GROWTH CURVE WITH STEPPED RELIABILITY PROJECTIONS





RELIABILITY GROWTH METHODOLOGY

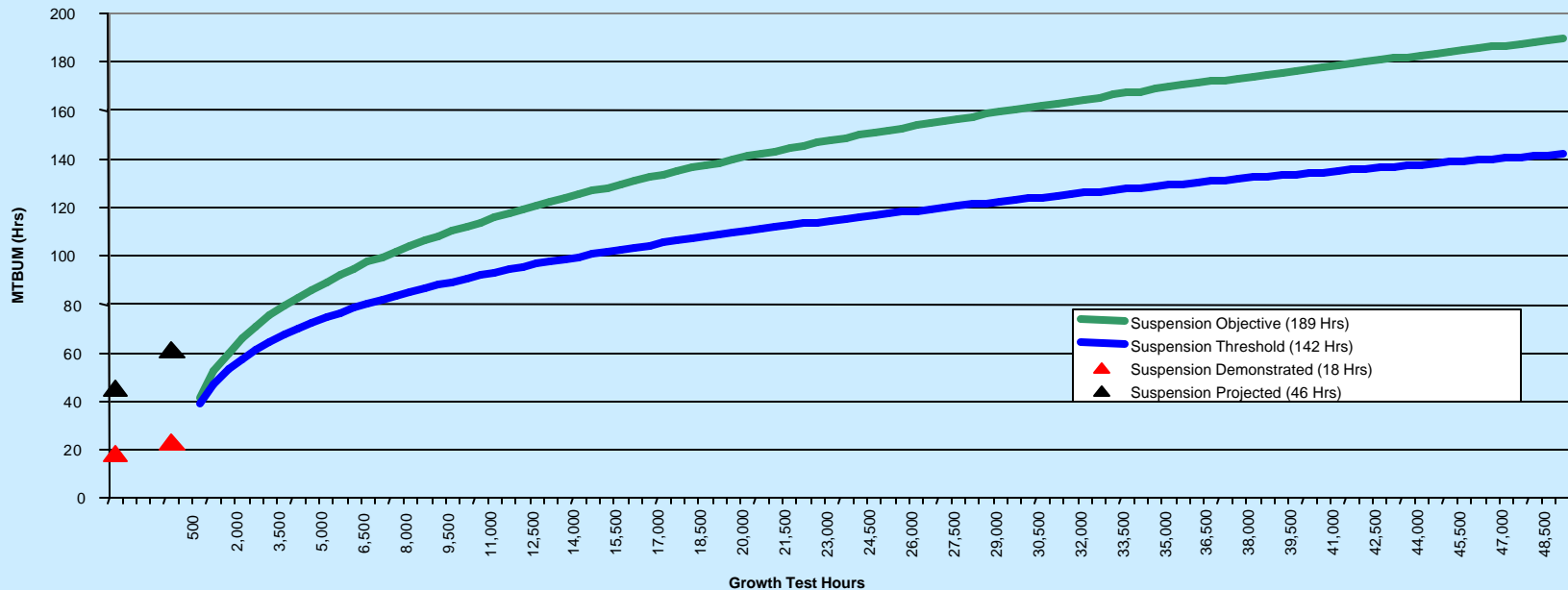


- **Idealized Reliability Growth curve established for SDD using AMSAA-Crow model**
- **Reliability requirements allocated to subsystem level**
- **Failure events documented in Failure Reporting, Analysis and Corrective Action System (FRACAS)**
- **Failure Mode Indicators (FMIs) employed to develop failed item Histograms**
- **Safety, Operational Mission Failures and Trends processed by Failure Prevention Review Board (FPRB)**
- **Corrective actions approved and scored by FPRB**
- **Demonstrated and projected reliability recorded on the growth curve**



IPT LEVEL GROWTH TRACKING

Suspension Growth Curve



Reliability Drivers	Planned Improvements	Cost Impact	Wgt Impact
Track Impact Performance	New Steel Track development	DEC	INC
HSU Seal Reliable Performance	Enhanced new seal replacement	N/A	N/A
HSU Connecting Bar Robustness	Increasing the cross section for area & inertia strength and handling higher loads	N/A	Min inc



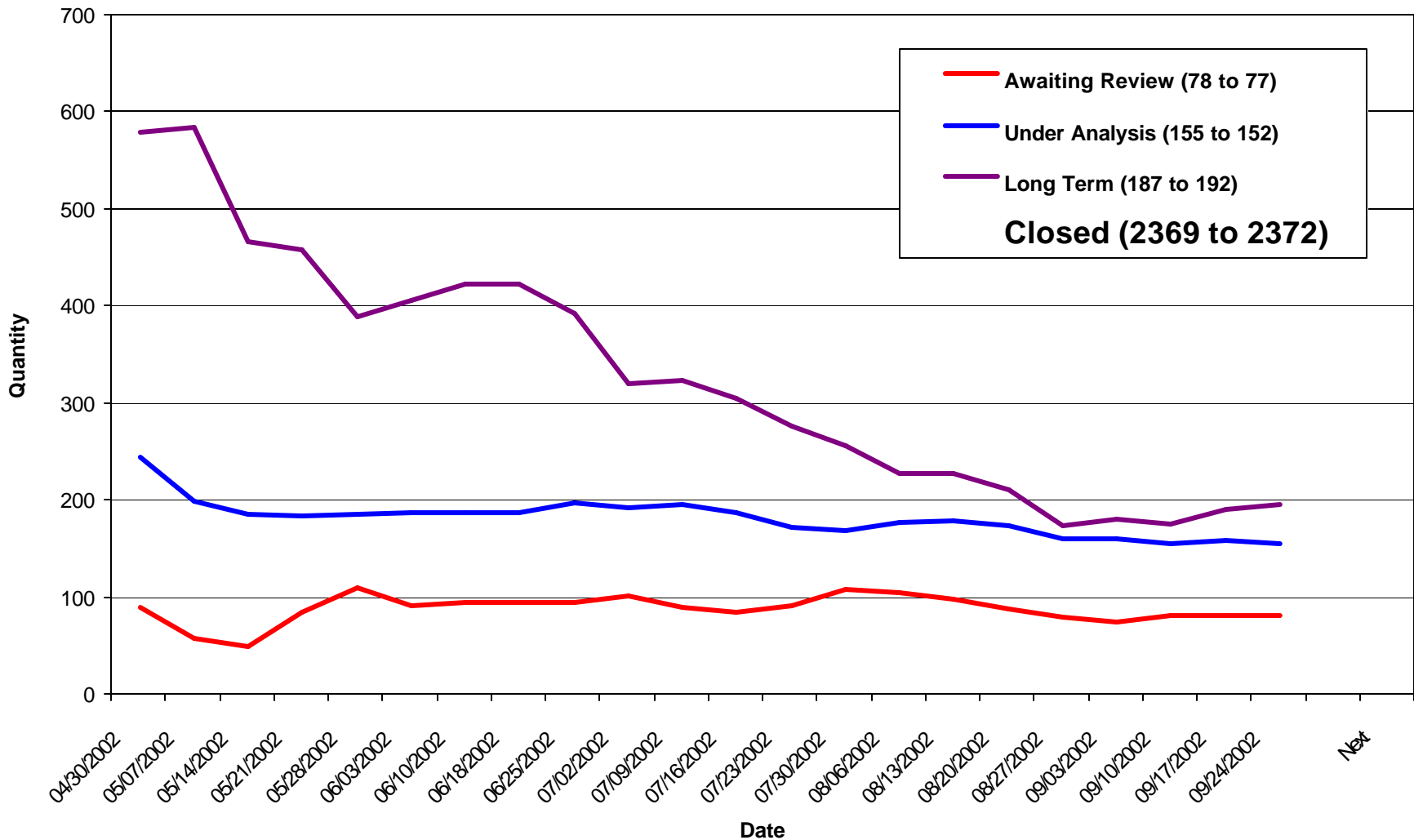
Failure Reporting, Analysis and Corrective Action System (FRACAS)



- A closed loop process
 - for the collection for failure event information
 - to support Root Cause Analysis
 - to document corrective actions
- Each Failure Report contains a Failure Mode Indicator (FMI) and Fix Effectiveness Factor (FEF)
- FRACAS reports are the primary source of data for use by the Failure Prevention Review Board



Overall FRACAS Status





Failure Mode Indicator Examples

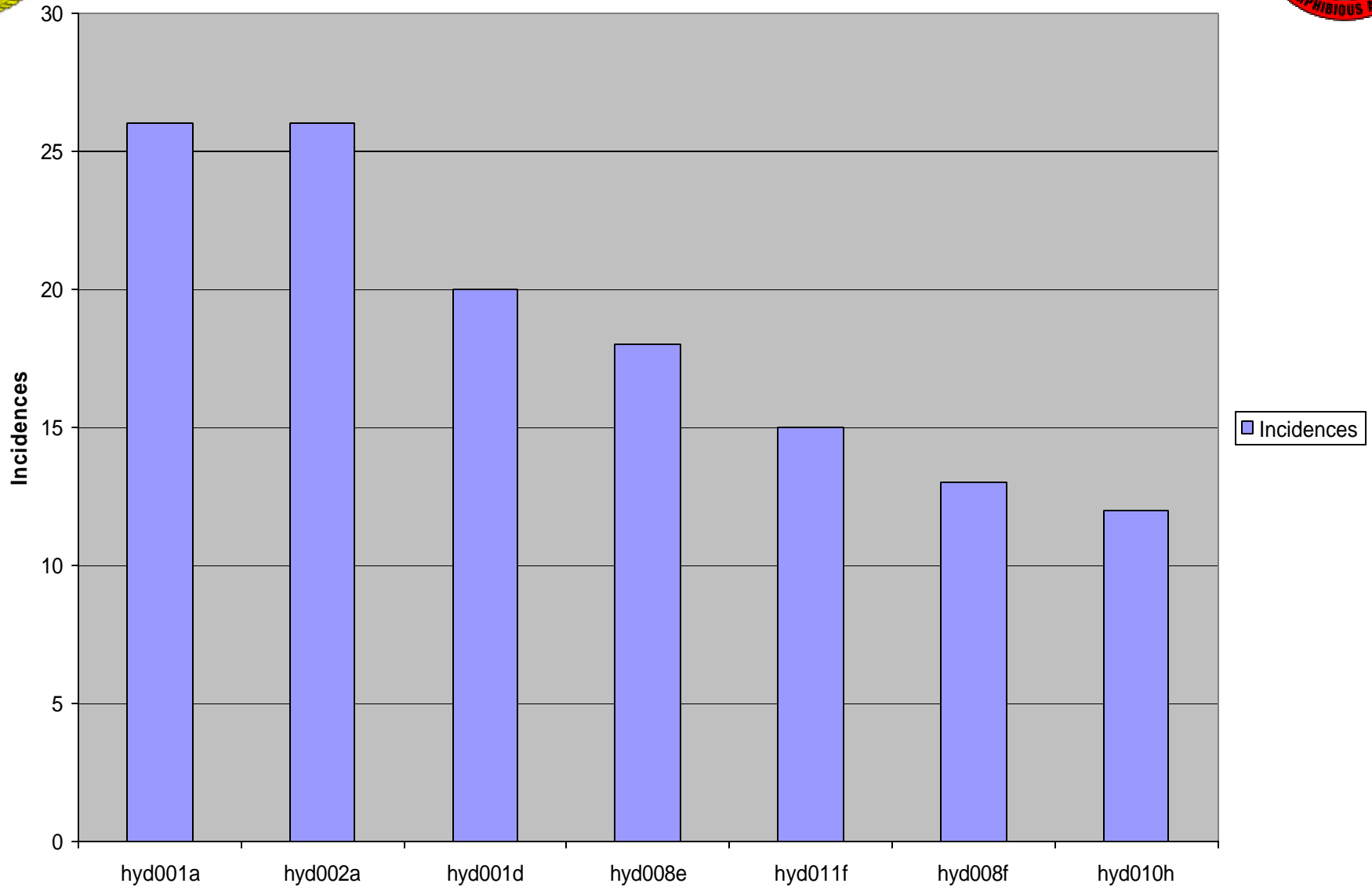
Hydraulic Failures



FMI	GROUP	Failure Mode	Equipment
• HYD001	AA	Leak, Interface	Line, Hydraulic
• HYD002	AA	Leak, Structural	Line, Hydraulic
• HYD003	AA	Chaffing	Line, Hydraulic
• HYD004	AA	Corrosion	Line, Hydraulic
• HYD005	AA	Damaged (I.e. Bent)	Line, Hydraulic
• HYD006	AA	Miscellaneous	Line, Hydraulic
•			
• HYD001	BB	Leak, Interface	Hose, Hydraulic
• HYD002	BB	Leak, Structural	Hose, Hydraulic
• HYD003	BB	Chaffing	Hose, Hydraulic
• HYD004	BB	Corrosion	Hose, Hydraulic
• HYD005	BB	Damaged	Hose, Hydraulic
• HYD006	BB	Miscellaneous	Hose, Hydraulic



Hydraulic FMIs by Incidence





FAILURE PREVENTION & REVIEW BOARD (FPRB)



- Joint System Level Committee Focusing on Root Cause Analysis Process for Test and Evaluation Anomalies
- Primary Members Include System Integrators, Logistics, and the Marine Proponent
- Ability To Redirect Resources & Prioritize Redesign
- Focus
 - Safety Related Anomalies
 - Operational Mission failures
 - Trends
- Currently 400 + Failure Reports Reviewed and Scored By The FPRB
- Assigns Fix Effectiveness Factor (FEF)



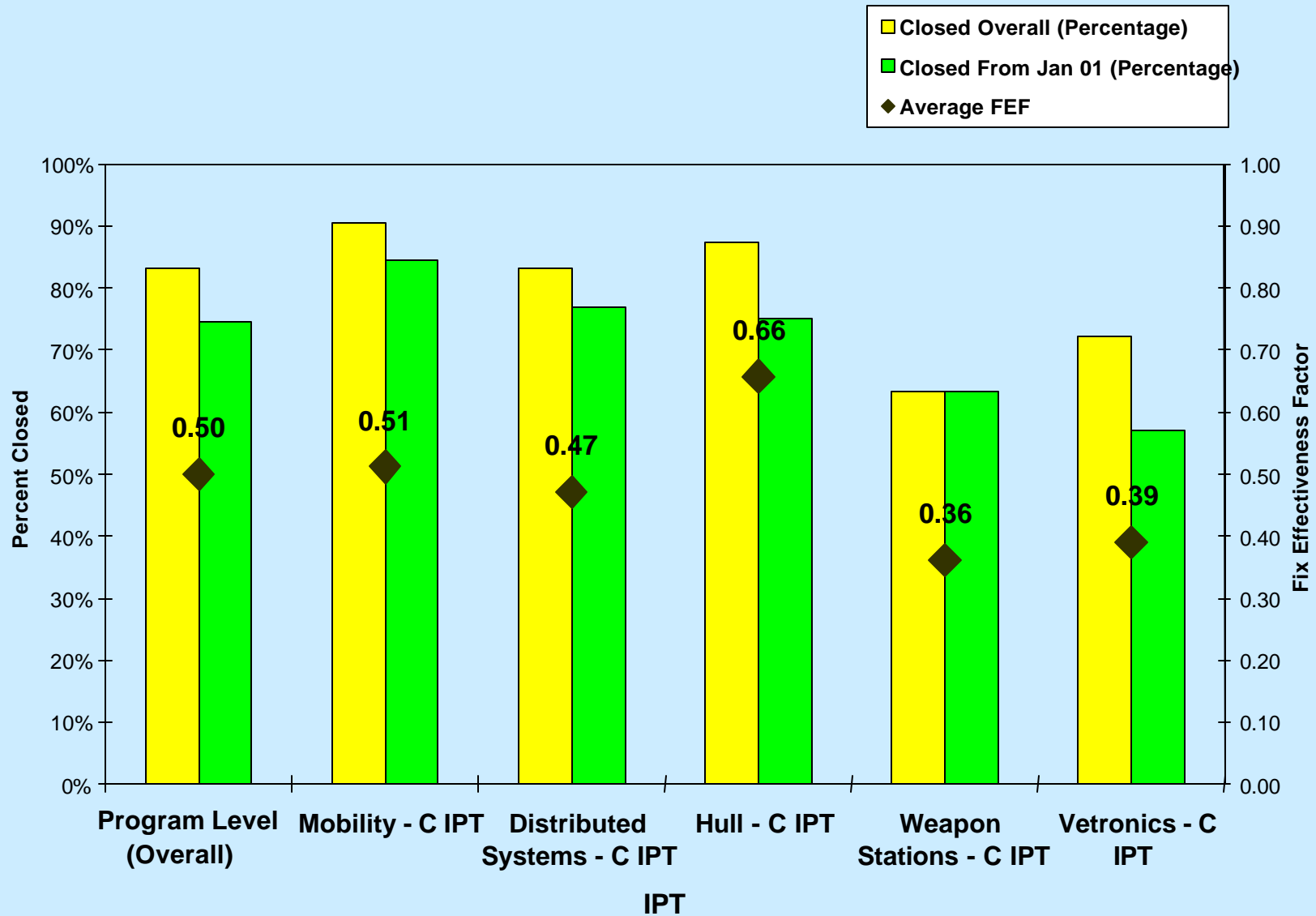
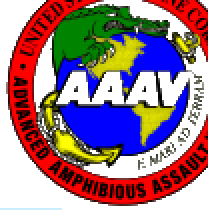
Fix Effectiveness Factors for Resolution of Failures

Fix Effectiveness Factor	Qualitative Effect	Effectiveness Criteria
1.0	<u>Failure mode eliminated</u>	<u>Component eliminated</u> or S/W changed to prevent problem recurrence.
0.9	<u>Extremely high probability</u> that the underlying failure mode will not reoccur	Extensive <u>RCA methodology</u> and <u>vehicle test data</u> verifies problem resolution.
0.8	<u>High probability</u> that the underlying failure mode will not reoccur	<u>RCA methodology</u> applied along with <u>component test data</u> to verify problem resolution.
0.7	<u>Above average</u> probability that the underlying failure mode will not reoccur	<u>RCA methodology</u> applied along with <u>vendor/test bed data</u> or <u>empirical data</u> (e.g. FEA or materials analysis) to verify the problem resolution.
0.5	<u>Medium probability</u> that the underlying failure mode will not reoccur	<u>Limited RCA methodology</u> applied along with <u>engineering analysis</u> to define the problem resolution.
0.3	<u>Low probability</u> that underlying failure mode will not reoccur	<u>Engineering judgement</u> applied to define the problem resolution.
0.0	<u>No Effect On The Design</u>	1. Failure data not captured thereby prohibiting failure analysis, or 2. Failure Mode not repeatable or fix not economical, or 3. Any anomaly that requires no investigation and is not expected to reoccur (e.g. test equipment failure, maintenance induced failure, etc.).

- FEF Exception – An exception to the FEF Criteria is allowable when the proposed fix is intuitively obvious; e.g. keystroke error in written programming code. These recommended FEFs should be documented in the remarks section of the FRACAS report.



Fix Effectiveness Factors (Subsystem Level)





Reliability Centered Maintenance



- Uncovers failure modes early in the design process
 - Timely design influence
- Provides design change recommendations based on a structured design review process
- Teams consist of those who know the selected equipment the best - designers, maintainers, log personnel
- RCM-II Example (Engine)
 - RCM-II identified 204 potential failure modes
 - FRACAS records indicate 92 failure modes
 - Following comparison of actual failure modes to what resulted from the RCM-II process, all but 4 failure modes were documented.
 - Failure modes not yet experienced in test were referred to engineering for analysis and proactive corrections to the design
- Applying to processes as well as products



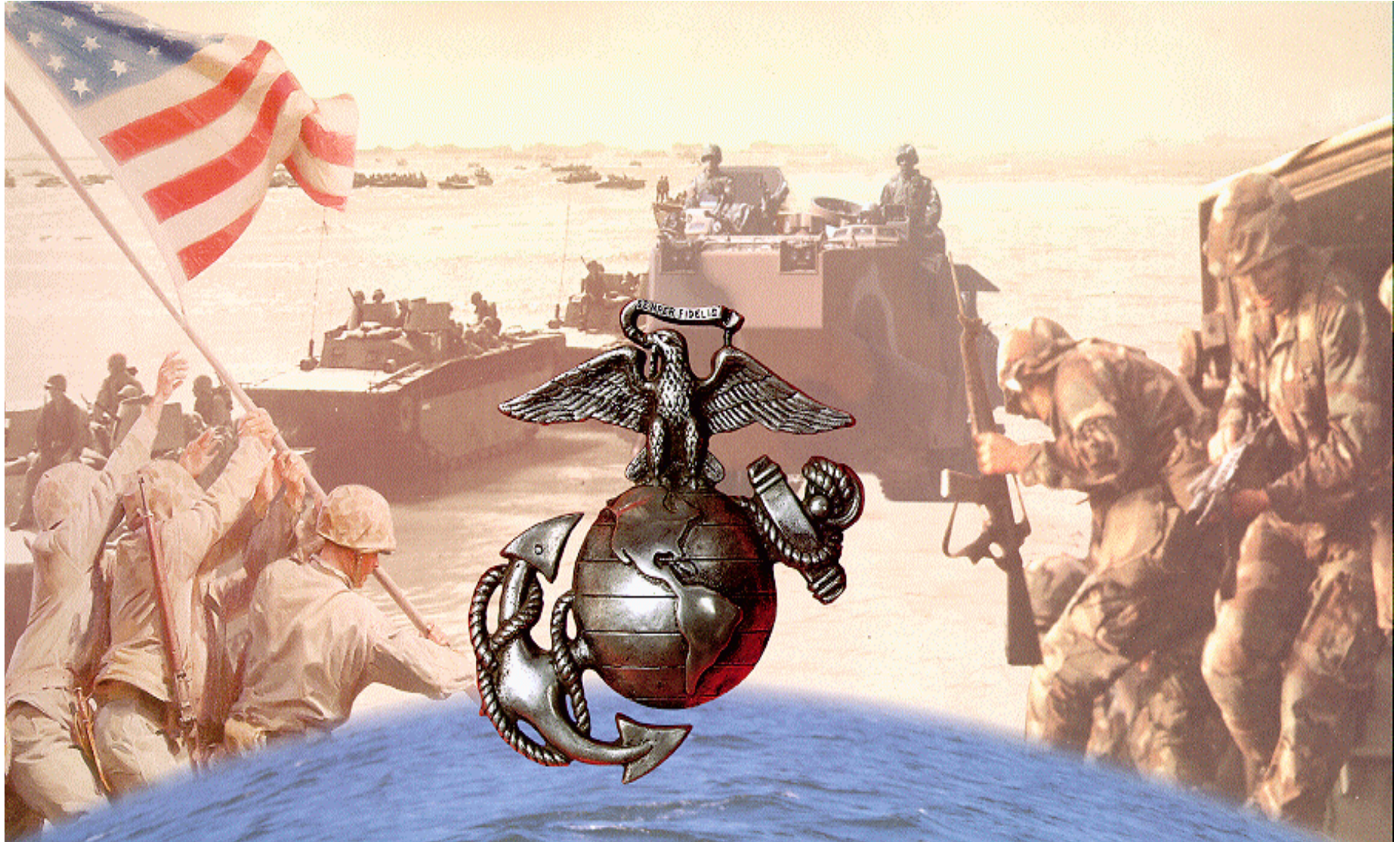
In Summary



- SDD design focus is driven by test anomalies and Reliability Centered Maintenance findings
- Integrated functionality in PDRR prototypes allows for earlier identification of failure modes
- Reliability Centered Maintenance uncovers failure modes before they happen
- SDD Reliability Growth Program plan includes refurbishment periods to allow for the introduction of corrective actions
- SDD Reliability Growth Projections utilize demonstrated reliability and apply fix effectiveness factors of defined corrective actions



QUESTIONS





AAAV (C)



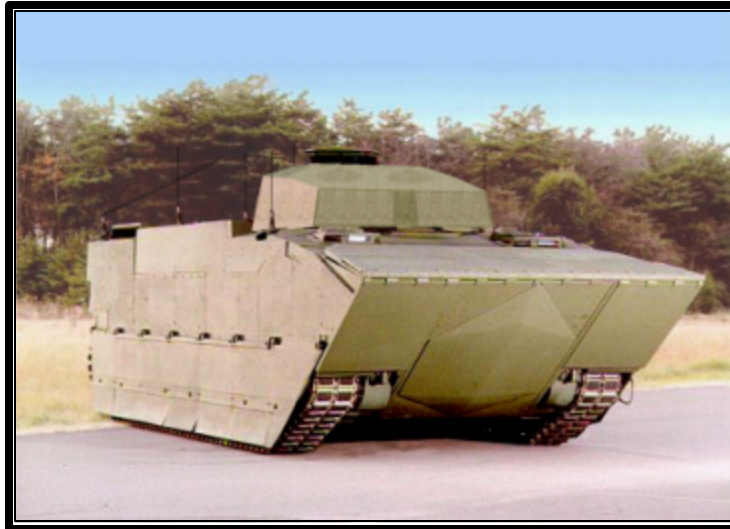
“State of the Art C4I Architecture”

MISSION

- Provide high speed transport and command and control capability to the embarked Commander and Staff in all operating environments.
- Enable the embarked battalion/regimental commander and his staff members to function as a battalion or regimental tactical echelon command post.

C2 SYSTEMS

- Advanced Field Artillery Tactical Data System
- C2 Personal Computer
- Intelligence Analysis System
- Tactical Combat Operations
- Flexibility for Technology and Software Enhancements



NAVIGATION SYSTEMS

- Global Positioning System
- Inertial Navigation System
- Digital Compass

VEHICLE PERFORMANCE

- Crew of 3
- Mobility, Armor Protection, Same as the AAAV(P)
- 7.62mm, M240 Machine Gun

COMMUNICATION CAPABILITY

- 6-9 Man Staff Capable
- Single Channel Ground and Air Radio Systems
- Enhanced Precision Location Reporting System
- Multi-Mode Multi-Band Radios
- Wireless Voice Intercom
- Migration to Joint Tactical Radio System planned for the future
- Interoperable
- VHF, UHF, HF, UHF (SATCOM) Capable



TEST, ANALYZE AND FIX (TAAF)



- TAAF process not new - used by NASA in the 60s and promoted by U.S. Navy since early 70s
- Elements of a TAAF Program
 - Testing conducted using simulated operational mission and environmental profiles
 - Determines design and manufacturing process weaknesses
 - TAAF process integrated with other development test activity
 - Safety and Operational Mission Failures, as a minimum, are subjected to root cause analysis
 - Corrective actions developed and incorporated into the platform
 - Fix effectiveness is measured